Intra-annual variations in coral skeletal geochemistry

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Massive tropical corals are useful paleoenvironmental archives because their inclusive records can be accurately dated and sampled with subannual resolution for an array of geochemical tracers within their exoskeletons. Climate reconstructions with these archives have investigated inter-annual to centennial-scale fluctuations yet seasonal variability is typically removed to examine anomalies. Intra-annual variability can provide useful insight into climate change as well as a means to constrain chronologies and assess fidelity of sampling methods. Corals do not grow at a constant rate thus it is important to capture the full seasonal cycle to avoid biasing the reconstruction toward the season with more growth. *Porites* spp. and *Siderastrea siderea* corals capture the full seasonal cycle with monthly samples for coral Sr/Ca, $\delta^{18}O$, and $\delta^{13}C$. Comparisons between *S. siderea* and *Montastraea* spp. corals growing in close proximity reveal seasonal cycles in coral Sr/Ca are reduced in *Montastraea* suggesting more time averaging per sample. Seasonal cycles are useful in detecting suboptimal sampling in *Porites* and *S. siderea* as well as missing and false years due to shifts in growth direction within a core. Despite the advantages of subannual sampling, the largest source of uncertainty in a monthly-resolved coral temperature reconstruction is the assignment of an absolute calendar month to an individual sample (±1–3 months) yet this uncertainty does not preclude examination of intra-annual or longer scale variability.

Multi-century long coral records can provide insight into seasonal variability. For example: a monthly-resolved coral Sr/Ca record from the southeast Gulf of Mexico spanning 1734–2008 reveals winter sea surface temperature (SST) extremes are more variable than summer SST extremes (±2.2ºC vs. ±1.6ºC) due to Loop Current transport. Summer SST failed to reach the thermal definition (>28.5ºC) of the Western Hemisphere Warm Pool (WHWP) for 35% of the years in the 1700s compared with 13% for the 20th century suggesting reductions in the WHWP during the Little Ice Age. Intra-annual variations in smaller corals are useful as well. Nine years of coral Sr/Ca and $\delta^{18}O$ variations in an early Holocene Tahitian coral reveals approximately the same or greater seasonal variability suggesting shifts in hydrology. Regardless of coral record length, these archives are capable of providing insight into tropical seasonal climate variability.